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LANDSAT DATA CONTINUITY MISSION

OPERATIONAL LAND IMAGER (OLI)

SPECIAL TEST REQUIREMENTS

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Goddard Space Flight Center
Greenbelt, Maryland

National Aeronautics and Space Administration

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LDCM PROJECT
DOCUMENT CHANGE RECORD

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REV LEVEL	DESCRIPTION OF CHANGE	DATE APPROVED

CHECK THE LDCM NGIN WEBSITE AT:
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1.0 Introduction

The LDCM program elements are dependent on the preflight characterization and calibration of the instrument, and in particular on the data sets and written reports from those tests. It is through the preflight test reports that the required elements of the instrument Image Assessment System will be identified. In addition, the algorithms to produce the L1R and L1G image products will be developed using these preflight data sets.
The purpose of the pre-flight and post-flight test requirements is to:

- verify that the instrument's operation conforms to specifications;
- establish the instrument's as-built performance;
- test for abnormalities in the sensor's response;
- provide an at-launch estimate of the sensor's radiometric calibration;
- provide calibration data sets that are otherwise unobtainable in flight or on the ground (such as spectral band characteristics, PSF parameters, solar diffuser calibration); and
- determine the instrument's radiometric stability.

The following descriptions of test requirements serves as a template for the minimum set of tests that must be included in the calibration validation test plan as part of the Contract Data Requirements List (CDRL) and of the overall assurance program.

The OLI Instrument contractor has the responsibility for providing an NPOESS compatible instrument capable of providing well calibrated and well characterized specification compliant data, to ensure Landsat data continuity. The Government has the responsibility for independently assuring that the delivered instrument will be specification compliant on the NPOESS platform and sufficiently well calibrated and characterized to fulfill the Mission objectives. The following Special Test Requirements (STRs) are an essential component of that assurance program. The results of the tests shall be reported as part of the program's set of Contract Data Requirements Lists (CDRLs).

2.0 During the pre launch phase the contractor shall, at a minimum:

a) Characterize the relative spectral radiance response for each band of the instrument and the variation of this response within the band.

i. The in-band (between 1% response points) relative spectral radiance response shall be measured at the integrated instrument level under simulated on-orbit operating conditions (vacuum and focal plane temperatures). If only a representative sample of detectors are tested, then this sample shall include at least 10% of the detectors in each band uniformly distributed across the focal plane, i.e., samples from center and edges of each sensor chip assembly.

ii. The Out-of-Band relative spectral radiance response of the instrument shall be determined down to a sensitivity of 5 orders of magnitude (below the peak in-band value) across the wavelength range of the sensitivity of the detectors used in the particular band. This determination shall be based on measurements of the mirrors as well as measurements made after detectors are mated to filters or at higher levels of assembly. The detector/filter measurements shall be made under operational temperature and angular conditions with adjacent bands illuminated. The integrated out of band response shall be determined using the solar exoatmospheric curve in section 4.2.4.2.3 of the instrument specification as a weighting function.

b) Characterize the stability of the spectral transmission of the spectral band bandpass filters between ambient and vacuum conditions at their expected operating temperature and angular conditions. Witness filters shall be measured in ambient and daily over at least 7 days of continuous vacuum exposure.

c) Characterize the spatial edge response based on measurements at the integrated instrument level under simulated on-orbit operating conditions (vacuum and temperatures) for a representative sample, i.e., 11 field angles (Scale Factors of Field of View (FOV): -1, -.89, -.77, -.63, -.44, 0, .44, .63, .77, .89, 1.0) across the entire FOV in all bands. Examine edge spread response data for possible crosstalk between spectral bands on the same focal plane.

d) Characterize the stray light rejection and internal light scattering of the instrument based on measurements at the component level or above and analysis. The stray light model shall be developed using a generally-accepted non-sequential ray trace method, e.g. ASAP, APART, GUERAP, Trace Pro. The stray light model shall encompass the spacecraft and other spacecraft instruments and the entire optical system, including baffles and the focal plane, detectors and mounting devices. Include a stray light analysis of the solar diffuser panel(s) in the deployed position. This analysis shall include glints and shadowing on the diffuser by the spacecraft and other spacecraft instruments as well as the instrument itself. As part of this analysis, demonstrate that diffuser measurements on orbit are not contaminated by reflected light from the earth and the atmosphere. Collect data at the integrated instrument level sufficient to look for instrument stray light effects not predicted by the stray light model. Characterize the throughput of any diffuser stray light baffling system. Characterize all applicable spectral bands to allow for possible improvements to the instrument stray light model. Included within this general stray light characterization and analysis special test requirement are measurements and analysis to confirm a more specific type of stray light, which is addressed in the ghosting system specification requirements. In tests at the integrated instrument level associated with this requirement verification the minimum size object diameter for testing will be equivalent to the larger of an enclosing diameter of 1/10 of the FPA across-track FOV or twice the SCA extent.

e) Radiometrically calibrate all detectors at the integrated instrument level in absolute units with NIST traceability under simulated on-orbit operating conditions (vacuum and focal plane temperature). Characterize the calibration across the expected instrument operating temperature range. Collect sufficient calibration data sets and characterization data to demonstrate that the calibrated data will meet the absolute radiometric accuracy, radiometric signal to noise, and radiometric stability requirements on orbit.

f) Determine the mathematical equation(s) to convert the instrument output in DN to input radiance in W/m^2-sr-um. Demonstrate the validity of the equation(s) with integrated instrument level measurements for a sampling of detectors.

g) Characterize the on-board solar calibrator for on-orbit use. This shall include characterization of the bidirectional reflectance of the solar diffuser panel across the range of solar incidence angles and focal plane view angles to be used on orbit. In addition, characterize the angular throughput of any diffuser view limiting devices across the range of angles to be used on orbit. Conduct an integrated instrument level characterization of the radiometric throughput of the solar calibrator across a subset of the angles to be used on orbit.

h) Characterize additional on-board calibration devices for on-orbit use. This shall include characterization of the stability of the internal calibration lamp system. Provide an integrated instrument level observation of at least one device that is expected to be radiometrically stable through launch. This observation shall be repeatable on orbit to assess the transfer of the pre-launch radiometric calibration to on-orbit calibration (i.e., Transfer to Orbit Measurement).

i) Characterize the Signal to Noise Ratio (SNR) of all detectors for integrated instrument level measurements under simulated on-orbit operating conditions (across the on-orbit sensor temperature range and in vacuum) and across the dynamic range of the sensor.

i.1) For each SCA characterize the bias and dark level relationship between all imaging and dark reference detectors for integrated instrument level measurements under simulated on-orbit operating conditions (across the on-orbit sensor temperature range and in vacuum).

j) Characterize the coherent noise of the instrument with spacecraft level measurements under simulated on-orbit operating conditions including contributions from the spacecraft (across temperature range and in vacuum).

k) Characterize the linear polarization sensitivity of the instrument by component level measurements and analysis. Measure the linear polarization sensitivity of a sampling of detectors (center and edges of field of view) at the integrated instrument level.

l) Characterize the bright target recovery and pixel-to-pixel electrical crosstalk of the instrument by focal plane level or above level measurements.

m) Collect data at the integrated instrument level sufficient to look for image artifacts such as pattern noise, striping, etc. Characterize any observed image artifacts to allow for possible improvements to the imagery.

n) Characterize the instrument's lines-of-sight (LOS) via measurements of all detectors LOS relative to the instrument coordinate system.

o) Demonstrate the relative stability of the detector lines of sight by measuring the relative locations of a selected set of detectors from each band and each SCA over the expected range of operating temperatures, to an accuracy ≤ 1 μrad (1-sigma) (TBR). The selected set of detectors shall include, at a minimum, the first, middle, and last even detector, and the first, middle, and last odd detector from each band on each SCA.

p) Measure the alignment of the instrument optical axes relative to the instrument alignment reference cube.

q) Demonstrate the instrument's band-to-band internal geometry stability over the expected range of operating temperatures.

r) Characterize the response, as a function of vibration frequency, of any jitter and/or attitude sensing devices provided with the instrument.

s) Characterize the alignment relative to the instrument optical axes of any jitter and/or attitude sensing devices provided with the instrument.

t) Measure the alignment of instrument optical axes relative to the instrument mounting interface over the full operating range of any pointing mechanisms in the instrument

u) Characterize the alignment stability of the instrument optical axes relative to the instrument mounting interface over the full operating range of any pointing mechanisms in the instrument

v) Demonstrate the ability to accurately reconstruct and register images in the VNIR bands from data collected under conditions that simulate the on-orbit target motion. This demonstration may be performed in segments over the full FOV of the instrument. This demonstration shall also include, but not be limited to, post-environmental spacecraft-level ambient testing, using an external target, to validate performance.

w) Characterize the detector-sampling timing pattern via measurement of any detector-specific electronic delays, sample phasing (e.g., even/odd detector timing offsets), and frame rate (i.e., time between samples) for each detector.

x) Provide and maintain a list of FPA defects, which include dead, inoperable, and out-of-spec detectors for each band.

y) Characterize 1/f noise parameters baseline by measuring long dark collects and dark pixel collects under simulated on-orbit operating conditions (across the on-orbit sensor temperature range and in vacuum). Test includes, at a minimum, 6 acquisitions spaced 5 minutes apart or one long continuous data collect with a similar time span. This test shall be repeated on orbit.

2.1 During the Commissioning phase, i.e., prior to Initial Operational Capability, the contractor shall, at a minimum:

a) Characterize on-board calibrator initial on-orbit performance and health by testing reference source lamps operation and the solar diffuser. The Transfer to Orbit Measurement shall be completed (See STR 2.1.g).

b) Update the Detector Operability Status list with newly identified dead, inoperable, and out-of-spec detectors for each band (twice during Commissioning.)

c) Characterize the bright target recovery and crosstalk of the instrument (once during Commissioning).

d) Characterize the relative detector response for detectors within a band (once during Commissioning) and update the calibration parameters to correct pixel-to-pixel non-uniformity as necessary.

e) Characterize the stability and absolute radiometric calibration of the spectral bands (once during Commissioning [or more frequently depending on stability of instrument]) and update the absolute calibration coefficients and uncertainties as required to meet performance specifications.

f) Characterize the noise of the instrument at dark (both coherent and total noise) and at multiple illuminated levels between dark and L(high) (twice during commissioning).

g) Characterize the Dark bias drifts, 1/f noise parameters, and FPA detector statistics over an orbit for at least three different dark data collection methods (i.e. Earth scene of cold sea at night, dark reference detectors, closed shutter) (twice during Commissioning).

h) Characterize the instrument to Attitude Determination System Reference Alignment. The characterization shall include the combined optical axes to instrument and instrument to attitude reference alignment, which is equivalent to the knowledge of the optical axes to star trackers alignment.

i) Characterize the band locations on the focal plane(s) relative to the pan band (twice during Commissioning).

j) Measure the relative locations of the individual SCAs on the focal plane (twice during Commissioning) to an accuracy ≤ 2 μrad (1-sigma).

k) Characterize any variations in detector responsivity over a minimum of 2 instrument out gassing cycles periods during commissioning.

l) Examine the stray light and ghosting of the instrument (twice during commissioning).

2.2 All radiance calibration sources and transfer radiometers used by the contractor prior to launch shall be calibrated to National Institute of Standards and Technology (NIST) standards for radiometric calibrations.